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Direct observation of fluid-clay interactions with implications for mechanical and electrical properties*

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When measuring sound speed in dilute sand-clay mixtures, observed changes in energy transmission have indicated that the pore fluid composition, as well as the amount of clay, may influence the acoustic properties of the medium. We devised an experiment to directly observe how sand and clay particles interact on the grain scale. An optical microscope was used to observe changes in clay morphology as a function of the chemistry of the pore fluid. We used a pure silica sand with grain sizes between 74-420 microns and a median diameter (d_{50}) of 273 microns, mixed with 1, 3, and 10 weight-% of sodium montmorillonite, a swelling clay. The wetting fluids were deionized water and a 0.1 N $CaCl_2$ solution. For the dry sand-clay mixture, we observed that the clay particles would electrostatically cling to the sand grains tending to bridge the gaps and thus influence the acoustic and electrical properties of the combined medium. As expected, due to the chemical interactions between the clay and the water, the clay particles swelled to occupy the available pore space between sand grains when wetted with deionized water. Subsequently, when wetted with $CaCl_2$, the clay particles settled and clumped together to form larger clusters or flocs by a process called flocculation. The flocculation process depends mainly on the charge that may be present on the particles in solution. The charge on each particle may repel the other particles and keep the material in suspension, or it may cause the particles to be attracted to each other and form clusters (or flocs). The visual observation of these phenomena verifies our initial assumption that fluid-clay interactions can play a major role when making acoustic and electrical measurements on natural soils. For more information, please visit our web-site at http://www-ep.es.llnl.gov/www-ep/esd/expgeoph/Berge/EMSP.

Prefer Poster presentation

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